

Plant Assessment Form

For use with the “Criteria for Categorizing Invasive Non-Native Plants that Threaten Wildlands”
by the California Exotic Pest Plant Council and the Southwest Vegetation Management Association
(Warner et al. 2003)

Printable version, February 28, 2003
(Modified for use in Arizona, 07/02/04)

Table 1. Species and Evaluator Information

Species name (Latin binomial):	<i>Chondrilla juncea</i> L. (USDA 2005)
Synonyms:	None identified in USDA (2005).
Common names:	Rush skeletonweed, skeletonweed, hogbite
Evaluation date (mm/dd/yy):	05/15/04
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Committee review date:	6/23/04 and 04/15/05
List date:	04/15/05
Re-evaluation date(s):	

Table 2. Scores, Designations, and Documentation Levels

Question		Score	Documentation Level	Section Scores	Overall Score & Designations
1.1	Impact on abiotic ecosystem processes	B	Reviewed scientific publication	“Impact” Section 1 Score: B	“Plant Score” Overall Score: Medium Alert Status: Alert
1.2	Impact on plant community	A	Reviewed scientific publication		
1.3	Impact on higher trophic levels	U	No information		
1.4	Impact on genetic integrity	D	Reviewed scientific publication		
2.1	Role of anthropogenic and natural disturbance	B	Observational	“Invasiveness” <i>For questions at left, an A gets 3 points, a B gets 2, a C gets 1, and a D or U gets=0. Sum total of all points for Q2.1-2.7:</i> 17 pts Section 2 Score: A	
2.2	Local rate of spread with no management	A	Observational		
2.3	Recent trend in total area infested within state	B	Observational		
2.4	Innate reproductive potential	A	Reviewed scientific publication		
2.5	Potential for human-caused dispersal	B	Reviewed scientific publication		
2.6	Potential for natural long-distance dispersal	B	Reviewed scientific publication		
2.7	Other regions invaded	A	Other published material		
3.1	Ecological amplitude	B	Other published material	“Distribution” Section 3 Score: C	<div>RED FLAG NO</div> Something you should know.
3.2	Distribution	D	Observational		

Table 3. Documentation

Question 1.1 Impact on abiotic ecosystem processes	Score: B Doc'n Level: Rev. sci. pub.
Identify ecosystem processes impacted: <i>Chondrilla juncea</i> causes hydrological changes in areas invaded by lowering the watertable due to its deep tap root. <i>Chondrilla juncea</i> absorbs large amounts of Nitrogen, lowering its level in adjacent soil.	
Rationale: No known study has been conducted in Arizona to assess the impact on abiotic ecosystem processes. Studies conducted primarily in Australia found that <i>C. juncea</i> causes changes in groundwater flow and level due to its deep tap root that can penetrate to a depth of seven feet or more (Old 1981, Macdonald et al. 1989). <i>Chondrilla juncea</i> out-competes native rivals for nitrogen, leading to a transformation of soil biochemistry (McVean 1966, Panetta and Dodd 1987b, Sheley et al. 1999).	
Sources of information: See cited literature.	
Question 1.2 Impact on plant community composition, structure, and interactions	Score: A Doc'n Level: Rev. sci. pub.
Identify type of impact or alteration: <i>Chondrilla juncea</i> forms dense monocultures on rangelands. Outcompetes native plants for both nitrogen and water, and out-reproduces native plants through production of large quantities of seed that can remain viable in dry climates for >8 years.	
Rationale: <i>Chondrilla juncea</i> invasion of rangelands typically establishes monocultures in disturbed or degraded areas where nitrogen levels are low and shading plants are sparse (McVean 1966, Panetta and Dodd 1987b). Stands of <i>C. juncea</i> become dense, and because it is a competitor for water and nitrogen it pushes out native plant species and can drastically reduce the plant bio-diversity in an invaded area (Sheley et al. 1999). In sandy and gravelly soils roots will branch from the taproot and are capable of spreading several feet, each one able to produce daughter rosettes. Rapid reproduction depletes nitrogen and moisture, displacing native species rapidly. When agricultural lands were invaded in Australia, wheat yields dropped by 80% (Sheley et al. 1999).	
Sources of information: See cited literature.	
Question 1.3 Impact on higher trophic levels	Score: U Doc'n Level: No info.
Identify type of impact or alteration: <i>Chondrilla juncea</i> forms thick monocultures that can push out and reduce native forage, fibrous flowering stem may cause choking and loss of condition.	
Rationale: No known formal studies have been conducted in Arizona to assess the impact on higher trophic levels. <i>Chondrilla juncea</i> forms thick monocultures that can drastically reduce native forage (Sheley et al. 1999). Evidence presented in Australian and Canadian literature indicates that rush skeletonweed is consumed during particular growth phases by domestic sheep, goats, horses, and cattle, and by some wildlife species (Panetta and Dodd 1987b, McVean 1966, Martin 1997, Harris 2003). Rosette leaves and stems prior to flowering are more palatable to domestic sheep and other domestic animals, though domestic goats and wild herbivores will consume the older, more fibrous stems as well (McVean 1966, Harris 2003). The fibrous flowering stem may cause choking and loss of condition when eaten by dairy cattle (Panetta and Dodd 1987b).	
Sources of information: See cited literature.	
Question 1.4 Impact on genetic integrity	Score: D Doc'n Level: Rev. sci. pub.
Identify impacts: Typically does not hybridize. No known native congeners occur in Arizona.	
Rationale: <i>Chondrilla juncea</i> is an apomict, reproducing without pollination or genetic recombination, and as a result forms distinct genetic bio-types and rarely hybridizes (McVean 1966, Cuthbertson 1974, Panetta and Dodd 1987b). Kearney and Peebles (1960) do not identify any native <i>Chondrilla</i> in Arizona.	
Sources of information: See cited literature.	

Question 2.1 Role of anthropogenic and natural disturbance in establishment	<i>Score: B Doc'n Level:</i>
Obs.	
Describe role of disturbance: Human disturbance is the primary means of spread. Road construction and field cultivation produces soil conditions susceptible to <i>C. juncea</i> . <i>Chondrilla juncea</i> thrives along roadsides and other disturbed areas, from which it spreads into adjacent areas.	
Rationale: Lori Makarick (personal communication, 2004) reports that rush skeletonweed initially invaded the Grand Canyon National Park in the heart of the developed zone. The initial invasion of the park followed the well established pattern of <i>C. juncea</i> invasion documented in many studies (McVean 1966, Panetta and Dodd 1987a, b). McVean (1966) reports that the initial expansion of invasion in Australia by rush skeletonweed was facilitated by rail and stock movements. Human disturbance is the primary means by which <i>C. juncea</i> establishment as rush skeletonweed rarely invades healthy native vegetation (McVean 1966, Sheley et al. 1999). Although <i>C. juncea</i> can spread into undisturbed areas, the pattern of invasion is typically from roadsides into adjacent cultivated fields or heavily grazed rangeland (McVean 1966, Panetta and Dodd 1987a, b, Sheley et al. 1999). Cultivation of infested fields then becomes the primary factor of spread because <i>C. juncea</i> can produce shoots from root fragments created by mechanical injury of the plant (Old 1981).	
Sources of information: See cited literature. Primary consideration also was given to a personal communication with L. Makarick (Below the Rim Vegetation Program Manager, National Park Service, Grand Canyon National Park Science Center, Flagstaff, Arizona).	
Question 2.2 Local rate of spread with no management	<i>Score: A Doc'n Level: Obs.</i>
Describe rate of spread: Under optimal conditions, skeletonweed can double in <10 years.	
Rationale: Lori Makarick (personal communication, 2004) reports that an unmanaged patch of skeletonweed spread from ~ 4.43 m ² to over 6,300 m ² in just one year. According to McVean (1966), the initial spread of <i>C. juncea</i> in Australia was 15 miles (24 km) per year.	
Sources of information: See cited literature. Primary consideration also was given to a personal communication with L. Makarick (Below the Rim Vegetation Program, National Park Service, Grand Canyon National Park Science Center, Flagstaff, Arizona, 2004).	
Question 2.3 Recent trend in total area infested within state	<i>Score: B Doc'n Level: Obs.</i>
Describe trend: Actual observations, beyond that articulated by L. Makarick (personal communication, 2004) in question 2.2 are unavailable. Rate of spread is likely increasing, but less rapidly than doubling in <10 years.	
Rationale: No specific information on trend is available at this time; however, the Working Group inferred, based on the example provided by L. Makarick (personal communication, 2004) in question 2.2, that total area infested in the state is likely not stable but that more information is needed before it can said the rate of range expansion statewide is doubling in <10 years.	
Sources of information: Personal communication with L. Markarick (Below the Rim Vegetation Program, National Park Service, Grand Canyon National Park Science Center, Flagstaff, Arizona, 2004) and inference by members of the Working Group.	
Question 2.4 Innate reproductive potential	<i>Score: A Doc'n Level: Rev. sci. pub.</i>
Describe key reproductive characteristics: <i>Chondrilla juncea</i> reproduces sexually, asexually by apomictic seeds, and vegetatively from adventitious buds on roots. A single plant can produce up to 20,000 seeds, of which 90% germinate in the first year.	
Rationale: <i>Chondrilla juncea</i> reproduces asexually by apomictic seed and vegetatively from adventitious buds on roots(self fertilization creates clones, giving rise to dominating well-adapted biotypes). One plant can produce as many as 20,000 seeds, of which ~ 90% germinate, and can grow from rosette to seed maturity in one month. (Dodd and Panetta 1987). In sandy and gravelly soils roots	

will branch from the taproot and are capable of spreading several feet, with each one able to produce daughter rosettes, and a dense infestation has an estimated seed production of 70,000 m ² (McVean 1966, Rosenthal et al. 1968 and other references in Old 1981, Panetta and Dodd 1987b). Furthermore, skeletonweeds that are injured mechanically form shoots from any part of the main root, lateral root, or root fragments that are viable until they desiccate (Cuthbertson 1972 in Zouhar 2003). One mature plant can colonize an area by vegetative reproduction through rosettes formed on its spreading lateral roots.
Sources of information: See cited literature.

Question 2.5 Potential for human-caused dispersal	Score: B Doc'n Level: Rev. sci. pub.
Identify dispersal mechanisms: Vehicles, farm and road maintenance machinery, railroads and grazing. <i>Chondrilla juncea</i> also contaminates hay that has been harvested from an invaded area.	
Rationale: Lori Makarick(personal communication, 2004) reports that the initial invasion of Grand Canyon National Park was via anthropogenic vectors, primarily vehicular. <i>Chondrilla juncea</i> has the capability to spread long distances naturally, but once established in range, cultivated land, or on roadsides, its primary means of spread is by root fragmentation and seed contaminating fodder and farm and maintenance machinery (to the extent that machinery and vehicles in contact with, or passing through an area infested must be washed thoroughly and cattle grazing in infected areas quarantined for at least 14 days before moving into a new area) (McVean 1966, Old 1981, McLellan 1991, Sheley et al. 1999). <i>Chondrilla juncea</i> was first seen in Grand Canyon National Park along the rail tracks intersecting the park (K. Watters, personal communication, 2004).	
Sources of information: See cited literature. Consideration also was given to personal communications with L. Makarick (Below the Rim Vegetation Program, National Park Service, Grand Canyon National Park Science Center, Flagstaff, Arizona, 2004) and K. Watters (Research Technician, National Park Service, Grand Canyon National Park, Flagstaff, Arizona, 2004).	

Question 2.6 Potential for natural long-distance dispersal	Score: B Doc'n Level: Rev. sci. pub.
Identify dispersal mechanisms: Wind, animal fur, and passage through digestive tracts of animals. Root fragments created through any natural disturbance, such as flooding events, can be translocated down stream and produce viable plants.	
Rationale: <i>Chondrilla juncea</i> seeds are light-weight, with parachute-like pappus that enables it to disperse by wind over great distances (McVean 1966, Groves and Williams 1975, Dodd and Panetta 1987).	
Sources of information: See cited literature.	

Question 2.7 Other regions invaded	Score: A Doc'n Level: Other pub.
Identify other regions: Plant communities susceptible to invasion are: <i>Artemisia tridentata</i> (sage brush), <i>Stipa comata</i> (needle-and thread grass), <i>Aropyron spicatum</i> (bluebunch wheatgrass), <i>Poa secunda</i> (Sandberg's bluegrass), <i>Purshia tridentata</i> (bitterbrush), and <i>Agropyron spicatum</i> (bluebunch wheatgrass) (Sheley et al. 1999)	
Rationale: Sheley et al. (1999) identified these specific plant communities, but do not document specific geographic regions or areas of infestation.	
Sources of information: See cited literature.	

Question 3.1 Ecological amplitude	Score: B Doc'n Level: Other pub.
Describe ecological amplitude, identifying date of source information and approximate date of introduction to the state, if known: See Worksheet B and Zouhar (2003). <i>Chondrilla juncea</i> has a diverse geographic and environmental range, from Canada to the Southwest U.S. and up to 2000 feet in elevation. It prefers sandy or gravely well-drained soil, in climates with hot dry summers and cool winters without prolonged drought, and rainfall less than 250 mm (10 in) to more than 1200 mm (~50	

in). The wide range of adaptability gives *C. juncea* an advantageous flexibility (McVean 1966, Panetta and Dodd 1987b).

General climate: Rush skeletonweed occurs over a wide range of climatic conditions. The greater part of its native range lies in Mediterranean and steppe climates. Rush skeletonweed does not occur in the cool, maritime climates of extreme western Europe nor in arid, desert climates of central Algeria, southern Iraq or central Australia. Humid, subtropical climates are apparently suitable for rush skeletonweed, provided the winters are cool. Optimum conditions for rush skeletonweed in Australia include cool winters, warm summers without severe summer drought, a distinct increase in precipitation at the onset of the cool season, and additional spring rainfall (Moore 1964, McVean 1966, Panetta and Dodd 1987b). Summer-dry montane and Mediterranean habitats are favored by rush skeletonweed in the western U.S. (Harris 2003).

Soil characteristics, soil moisture: Where rush skeletonweed is native, it appears to favor coarse-textured, well-drained soils such as sand dunes, granite outcrops, and other coarse soils (McVean 1966). In all parts of its native range the soils on which rush skeletonweed grows appear to be calcareous or only mildly acid (Moore 1964, McVean 1966). In general, the soils on which dense infestations of rush skeletonweed were found in Mediterranean Europe had a relatively high percentage of sand and were low in nutrients (Tu et al. 2001, USDA 2001). According to Wapshere et al. (1976), the optimal nutrient level for rush skeletonweed is relatively low, and competition (promoted by high nutrient levels) is of much greater relative importance to rush skeletonweed survival than is nutrient availability.

In Australia, rush skeletonweed occurs on all but heavy clay soils and develops best and is most abundant on deep sands, sandy loams, and sandy-clay loams (Moore 1964, Cullen and Groves 1977, Panetta and Dodd 1987b). Rush skeletonweed plants generally do not establish on undisturbed, fine-textured soils (McVean 1966, Panetta and Dodd 1987b).

Soil types that favor establishment and persistence of rush skeletonweed support mesic-xeric to xeric plant communities. These communities naturally display very low density plant cover which provides rush skeletonweed seedlings a favorable environment for establishment. The coarse textured soils also allow for lateral root growth and horizontal spread of rush skeletonweed (Old 1981, 1990). Rush skeletonweed also occasionally occurs in deeper and/or finer textured soils when spread by root fragments (Old 1990). Because of the high degree of conformity of rush skeletonweed infestation to shallow or sandy-gravelly soil types.

Precipitation: In the western Mediterranean, maximum densities of rush skeletonweed occur in areas with a relatively hot, dry summer without a heavy drought, with an average rainfall of 16 to 28 inches (400-700 mm), relatively evenly distributed throughout the year (Wapshere et al 1974). In Australia rush skeletonweed has been recorded from districts with mean annual rainfalls ranging from 9 to 60 inches (230-1520 mm) (Moore 1964, McVean 1966, Wells 1971).

Timing of precipitation is important for establishment and spread of rush skeletonweed. In areas where summer showers followed by severe drying are common, the rush skeletonweed seed bank is likely to be depleted since seedlings are likely to die of desiccation, thus limiting its spread by seed (Cuthbertson 1966, McVean 1966, Schirman and Robocker 1967, Panetta 1988).

Elevation/aspect: The elevational range of rush skeletonweed is from close to sea level in Australia and Europe up to 5,100 feet (1,550 m) in Central Europe, Cyprus and the Southern Highlands of New South Wales, and up to 5,900 feet (1,800 m) in Armenia. In Australia, infestations along roadsides and sheep tracks are common at 4,000 to 4,900 feet (1,200 to 1,500 m), but these plants do not flower until the end

of March, by which time the flowering season below an altitude of 2,000 feet (600 m) has been completed. It has been observed that plants growing at elevations near 5,400 feet (1,650 m) in Australia may not flower until just before the onset of winter, so that little or no seed is set (McVean 1966). Rush skeletonweed occurs from sea level to 2,000 feet (0 to 600 m) in California (Hickman 1993) and up to 3,000 feet (950 m) in British Columbia (Harris 2003).

Germination: In general, rush skeletonweed seeds have high viability and high germination rates. Viability is not dependent on pollinators (Cuthbertson 1974) and does not appear to be affected by moisture availability during the growing season (Liao 1996), although it does appear to decrease during storage (Ballard 1956, Moore 1964, Cuthbertson 1970, Panetta 1989, Old 1981, 1990, Liao 1996). Germination of rush skeletonweed seeds does not require light (McVean 1966, Cuthbertson 1970) and occurs over a wide range of temperatures (Ballard 1956, Moore 1964, McVean 1966, Panetta 1987). Germination is sensitive to moisture availability and depth of seed burial (Cuthbertson 1970).

Cuthbertson (1974) found 95.8% seed viability from unstressed rush skeletonweed plants, while McVean (1966) found that, even under ideal germination conditions, up to 20% of ripe embryos may "remain dormant or die." Normally dispersed rush skeletonweed seeds collected in Washington gave no indication of innate dormancy. Immediately after collection, samples gave 95% germination on blotters (Schirman and Robocker 1967).

Germination of rush skeletonweed seed is sensitive to moisture availability. Cuthbertson (1970) found that rates and final percentages of germination were reduced progressively at osmotic tensions below - 0.2 MPa, until germination ceased at -1.6 MPa. Buried rush skeletonweed seeds germinated readily following summer rainfall events of less than 0.4 inch (10 mm) in Australia (Ballard 1956, Panetta 1989). Moisture loss may be rapid when fully or partially imbibed rush skeletonweed seeds are exposed to drying influences, so germination may be promoted by slight burial (Ballard 1956, McVean 1966, Panetta and Dodd 1987b). In Australian studies, rush skeletonweed seeds lying on the surface were much less likely to germinate in response to small rainfall events (Ballard 1956, Panetta 1989). Seedlings emerged successfully from rush skeletonweed seeds buried up to about 2 inches (5 cm) in sandy soil, but did not emerge from seeds at this depth in soils of finer texture (McVean 1966). Maximum depth of seed burial resulting in rush skeletonweed seedling emergence was 1 inch (2.5 cm) in a medium-textured soil, and no emergence was observed from seeds buried below 0.75 inch (2 cm) in clay soils (Ballard 1956 and references therein, Moore 1964, Panetta 1989). Rush skeletonweed seeds are sensitive to reduced oxygen and fail to germinate below the surface of waterlogged soil (McVean 1966).

Rationale: Worksheet B and above. Observed in two major and minor ecological types within the Grand Canyon National Park: scrublands (Great Basin montane scrub) and forests (montane conifer forest) (K. Watters, personal communication, 2004).

Sources of information: See cited literature. Also considered personal observations from K. Watters (Research Technician, National Park Service, Grand Canyon National Park, Flagstaff, Arizona, 2004).

Question 3.2 Distribution

Score: **D** Doc'n Level: **Obs.**

Describe distribution: Limited within the ecological types in which occurs.

Rationale: Observed only within the Grand Canyon National Park within two major and minor ecological types: scrublands (Great Basin montane scrub) and forests (montane conifer forest) (K. Watters, personal communication, 2004).

Sources of information: Personal observations from K. Watters (Research Technician, National Park Service, Grand Canyon National Park, Flagstaff, Arizona, 2004). No listings in SEINet (Southwest Environmental Information Network), Arizona herbaria specimen database (available online at: <http://seinet.asu.edu/collections>; accessed July 21, 2004).

Worksheet A. Reproductive Characteristics

Complete this worksheet to answer Question 2.4.

Reaches reproductive maturity in 2 years or less	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	1 pt.
Dense infestations produce >1,000 viable seed per square meter	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	2 pt.
Populations of this species produce seeds every year.	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	1 pt.
Seed production sustained for 3 or more months within a population annually	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	1 pt.
Seeds remain viable in soil for three or more years	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	2 pt.
Viable seed produced with <i>both</i> self-pollination and cross-pollination	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	1 pt.
Has quickly spreading vegetative structures (rhizomes, roots, etc.) that may root at nodes	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	1 pt.
Fragments easily and fragments can become established elsewhere	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	2 pt.
Resprouts readily when cut, grazed, or burned	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	1 pt.
Total pts: 12 Total unknowns: 0			
Score : A			
<p>Note any related traits: Seed viability over time as documented in studies varied from a few days to over eight years.</p>			

Worksheet B. Arizona Ecological Types

(*sensu* Brown 1994 and Brown et al. 1998)

Major Ecological Types	Minor Ecological Types	Code*
Dunes	dunes	
Scrublands	Great Basin montane scrub	D
	southwestern interior chaparral scrub	
Desertlands	Great Basin desertscrub	
	Mohave desertscrub	
	Chihuahuan desertscrub	
	Sonoran desertscrub	
Grasslands	alpine and subalpine grassland	
	plains and Great Basin shrub-grassland	
	semi-desert grassland	
Freshwater Systems	lakes, ponds, reservoirs	
	rivers, streams	
Non-Riparian Wetlands	Sonoran wetlands	
	southwestern interior wetlands	
	montane wetlands	
	playas	
Riparian	Sonoran riparian	
	southwestern interior riparian	
	montane riparian	
Woodlands	Great Basin conifer woodland	
	Madrean evergreen woodland	
Forests	Rocky Mountain and Great Basin subalpine conifer forest	
	montane conifer forest	D
Tundra (alpine)	tundra (alpine)	

*A means >50% of type occurrences are invaded; B means >20% to 50%; C means >5% to 20%; D means present but ≤5%; U means unknown (unable to estimate percentage of occurrences invaded).

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